

REMARKS

Claims 1-17 are pending in the present Application.

Reconsideration and allowance of the claims are respectfully requested in view of the above amendments and the following remarks.

Double Patenting

Claims 1-3, 8-10, 12-15, and 17 are provisionally rejected on the ground of nonstatutory obviousness-type double-patenting as being unpatentable over claims 1-6, 12, 14 and 19 of co-pending Application No. 10/568,458. As neither case has been allowed, the claims are not final in either case. Hence, it is requested that this rejection be held in abeyance at least until the claims have been deemed. MPEP § 804.01.I(B)(1).

Claim Rejections Under 35 U.S.C. § 103(a)

Claims 1-2, 9-14, and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Swatloski et al. (WO 03/029329).

Applicants respectfully traverse this rejection. The instant claims are directed to a method for depolymerizing starch, the method comprising mixing starch material with an ionic liquid solvent, and agitating the mixture at a temperature and for a period for time to effect depolymerization of the starch into the desired depolymerization products.

Swatloski et al. provides a method for dissolving pure cellulose in an ionic liquid, preferably assisted by microwave irradiation. As recognized by the Office, Swatloski et al. does not disclose dissolving starch, or dissolving starch in the absence of microwave radiation.

However, the Office holds that it would have been obvious to try using the method of Swatloski et al. with starch, motivated by the fact that cellulose and its derivatives can be used as a substitute source of polymers in paints, plastics, and other formulations. The Office further alleges that one of ordinary skill in the art would have had a reasonable expectation of success based on the fact that starch is less crystalline than cellulose, which is more difficult to hydrolyze due to its higher crystallinity and lower solubility in solution. (Office Action, p. 4.)

Applicants respectfully disagree, as due to the different chemical nature of cellulose and starch (which comprises amylose and amylopectin), one skilled in the art would not draw the conclusion that once cellulose can be dissolved in ionic liquids, starch could also be dissolved in ionic liquids.

However, even assuming that one skilled in the art would have a reasonable expectation of success for dissolving starch in ionic liquids, the claimed method would not be obvious in view of Swatloski et al. The Office appears to have given no weight whatsoever to the limitation in claim 1 that relates depolymerizing starch. In fact, the present claims are based on the surprising discovery that starch dissolved in ionic liquids can be depolymerized, even in the absence of any acid or base catalyst, or enzyme, thereby providing an efficient, gentle, environmentally benign and above all economically feasible depolymerization method for:

- either amylose selectively to yield pure amylopectin and sugars or
- both amylose and amylopectin to yield sugars (page 5, lines 16-21 of the specification).

Swatloski et al. does not disclose or suggest depolymerization of polysaccharides, but illustrates by means of examples how a dissolved pure cellulose can be precipitated as long-chained cellulose. Swatloski et al. does not teach anything about the possibility to depolymerize polysaccharides, let alone starch; nor does it contain any indication that ionic liquids could be employed in dissolution and, subsequent controlled depolymerization of starch. Swatloski et al. instead teaches that a polysaccharide material, i.e. cellulose, can be dissolved in ionic liquids, agitated at elevated temperatures and regenerated from water unambiguously without any significant change in the degree of polymerization or polydispersity. Thus, if there would be any analogy between cellulose and starch, Swatloski et al. teaches away from depolymerization of starch.

The Examiner argues that it would have been obvious to apply the teachings of Swatloski et al. into the treatment of starch, because cellulose and its derivatives can be used as a substituted source of polymers for application in paints, plastics and other formulation materials (page 1, paragraph 2 of Swatloski et al.). Firstly, as noted above, the cited paragraph

of Swatloski et al. does not even mention starch; and secondly, even if cellulose could be used as a substitute for starch in, e.g., paints, such use provides not motivation for dissolving starch in ionic liquids, followed by controlled depolymerization of the starch into desired depolymerization products.

Claims 3-8 and 15-16 are further rejected under 35 U.S.C. § 103(a) as being unpatentable over Swatloski in view of Bergstrom et al. (US 4,000,032).

Bergstrom et al. provides a process for freeing cellulose fibers from lignocellulosic material that comprises subjecting particulate lignocellulosic material to microwave irradiation at such an intensity that the water present in the lignocellulosic material is vaporized, and the lignocellulosic structure is disintegrated, thereby freeing the cellulose fibers (claim 1). The process produces a pulp comparable to mechanical pulp but has an improved strength (column 6, lines 9-12), and thus Bergstrom et al. provides an alternative process for producing mechanical pulp.

According to Bergstrom et al. (column 3, lines 38-51), the lignocellulosic material should have a high water content of at least about 10% up to about 90%, preferably from about 25% to 90% by weight. The high water content is necessary for the process because the water present in the lignocellulosic material rapidly absorbs the microwave radiation, thereby becoming heated to form steam which disrupts or disintegrates or even explosively destroys the structure (column 5, lines 1-10). The Examiner equates this disruption or destruction with “depolymerization.” Applicants note, however, that this term does not appear in Bergstrom et al., and is not descriptive of the process of Bergstrom et al. Depolymerization is the chemical transformation of polymers to their constituent oligomeric and/or monomeric units. In Bergstrom et al., the hot steam softens the lignin, and this in turn weakens the bond strength between the fibers; and due to this weakening, the fibers are easier to separate from the structure without shortening the fibers (column 5, lines 10-21). However, the treatment of Bergstrom et al. does not have any chemical effect on the lignin that binds the fibers to the lignocellulosic structure. Because there is no chemical disruption, the lignin cannot be separated from the cellulose, hemicellulose and the other components of the lignocellulose. It

is also important to note that the treatment of Bergstrom et al. does not have any deleterious effect on the length of the cellulose fibers, meaning that the cellulose is not depolymerized.

The main distinguishing features from the present claims are that Bergstrom et al. does not contain any dissolving step of any polymeric material, there are no ionic liquids involved, and the disruption method requires excessive contents of water in order to facilitate the freeing of cellulose fibers.

In conclusion, the main features distinguishing the claims from Bergstrom et al. are:

- i) the starch material is completely dissolved to form a homogenous solution and subsequently the dissolved starch is depolymerized into desired depolymerization products;
- ii) starch is totally different from the wood material (lignocellulose) of Bergstrom et al.;
- iii) the solvent of the claims is free from water or essentially free from water (page 7, lines 9-12); and
- iv) the end product of the process is a solution that contains depolymerization products of starch, such as mono and disaccharides (not a softened lignocellulosic material wherein the lignocellulosic material is in the form of an undissolved aqueous slurry as is disclosed by Bergstrom et al.)

Bergstrom et al. therefore does not contain any teaching of the possibility to dissolve polymeric material, let alone into ionic liquids or any other media. On the contrary, Bergstrom et al. teaches how to avoid any unnecessary dissolution of lignocellulosic material in order to free cellulose fibers from lignocellulosic material in high yield. This is achieved with high water contents of lignocellulosic material and microwave-assisted disruption of said material. This is contrary to the features of present claims, wherein the dissolution of the starch material must be carried out in the substantial absence of water. The combination of Swatloski et al. and Bergstrom et al. therefore would not result in the instant claims. Reversal of the rejections is therefore respectfully requested.

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(BP114592/JS/BK)

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and allowance are respectfully requested.

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 061130.

Respectfully submitted,

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